What is claimed is:

[Claim 1] 1. A bipolar plate for an electrochemical cell, comprising:

a first layer having a first plurality of through channels oriented in a first direction;

a second layer having a second plurality of through channels oriented in a second different direction;

a third layer disposed between and bonded to the first and second layers, the third layer having a first set of header channels in fluid communication with the first plurality of channels, and a second set of header channels in fluid communication with the second plurality of channels;

a first inlet port and a first outlet port in fluid communication with the first set of header channels; and

a second inlet port and a second outlet port in fluid communication with the second set of header channels;

wherein the bonded third layer prevents fluid communication between the first plurality of channels and the second plurality of channels.

[Claim 2] 2. The bipolar plate of Claim 1, wherein:

the first direction is oriented about 90 degrees to the second direction.

[Claim 3] 3. The bipolar plate of Claim 1, wherein:

the first inlet port and the first outlet port are diagonally disposed with respect to a fluid flow therebetween; and

the second inlet port and the second outlet port are diagonally disposed with respect to a fluid flow therebetween.

[Claim 4] 4. The bipolar plate of Claim 1, wherein:

the first layer has a first thickness;

each of the first plurality of channels has a first width;

the first width is equal to or greater than about the first thickness and equal to or less than about three times the first thickness;

the second layer has a second thickness;

each of the second plurality of channels has a second width; and

the second width is equal to or greater than about the second thickness and equal to or less than about three times the second thickness.

[Claim 5] 5. The bipolar plate of Claim 1, wherein:

the first layer has a first thickness;

each of the first plurality of channels has a first width;

the first width is equal to or greater than about 1.5 times the first thickness;

the second layer has a second thickness;

each of the second plurality of channels has a second width; and

the second width is equal to or greater than about 1.5 times the second thickness.

[Claim 6] 6. The bipolar plate of Claim 4, wherein:

the first width is greater than the second width.

[Claim 7] 7. The bipolar plate of Claim 5, wherein:

the first width is greater than the second width.

[Claim 8] 8. The bipolar plate of Claim 1, wherein:

the first set of header channels comprises a first through channel extending from the first inlet port, and a second through channel extending from the first outlet port; and

the second set of header channels comprises a third through channel extending from the second inlet port, and a fourth through channel extending from the second outlet port.

[Claim 9] 9. The bipolar plate of Claim 8, wherein:

the first, second, third, and fourth, through channels are isolated from each other.

[Claim 10] 10. The bipolar plate of Claim 1, wherein:

the third layer is diffusion bonded to the first and second layers.

[Claim 11] 11. The bipolar plate of Claim 1, wherein:

at least one of the first set of header channels and the second set of header channels of the third layer comprises a plurality of header channels.

[Claim 12] 12. The bipolar plate of Claim 1, wherein:

the first, second, and third, layers are made from titanium, zirconium, stainless steel, or any combination comprising at least one of the foregoing materials.

[Claim 13] 13. An electrochemical cell comprising:

a plurality of membrane-electrode-assemblies (MEAs) alternatively arranged with a plurality of flow field members between a first cell separator plate and a second cell separator plate;

wherein at least one of the plurality of flow field members comprises a bipolar plate, the bipolar plate comprising:

a first layer having a first plurality of through channels oriented in a first direction;

a second layer having a second plurality of through channels oriented in a second different direction;

a third layer disposed between and bonded to the first and second layers, the third layer having a first set of header channels in fluid communication with the first plurality of channels, and a second set of header channels in fluid communication with the second plurality of channels;

a first inlet port and a first outlet port in fluid communication with the first set of header channels; and

a second inlet port and a second outlet port in fluid communication with the second set of header channels;

wherein the bonded third layer prevents fluid communication between the first plurality of channels and the second plurality of channels.

[Claim 14] 14. The bipolar plate of the electrochemical cell of Claim 13, wherein:

the first layer has a first thickness;

each of the first plurality of channels has a first width;

the first width is equal to or greater than about the first thickness and equal to or less than about three times the first thickness;

the second layer has a second thickness;

each of the second plurality of channels has a second width; and

the second width is equal to or greater than about the second thickness and equal to or less than about three times the second thickness.

[Claim 15] 15. The bipolar plate of the electrochemical cell of Claim 14, wherein:

the first width is greater than the second width.

[Claim 16] 16. The electrochemical cell of Claim 15, wherein:

each MEA comprises an oxygen electrode and a hydrogen electrode; and

the first layer of the bipolar plate is proximate the oxygen electrode.

[Claim 17] 17. The bipolar plate of the electrochemical cell of Claim 15, wherein:

the third layer is diffusion bonded to the first and second layers.

[Claim 18] 18. The electrochemical cell of Claim 13, wherein the first plurality of through channels define a first active area, and further comprising:

a fluid flow seal about the first active area; and

a fluid flow seal about each of the inlet and outlet ports at the first layer.

[Claim 19] 19. The electrochemical cell of Claim 18, wherein the second plurality of through channels define a second active area, and further comprising:

a fluid flow seal about the second active area; and

a fluid flow seal about each of the inlet and outlet ports at the second layer.

[Claim 20] 20. An electrochemical cell comprising:

a plurality of membrane-electrode-assemblies (MEAs) alternatively arranged with a plurality of flow field members between a first cell separator plate and a second cell separator plate;

wherein at least one of the plurality of flow field members comprises a bipolar plate, the bipolar plate comprising:

first, second, and third, layers bonded together to form a laminated arrangement, the first layer having a first set of through channels, the second layer having a second set of through channels, and the third layer having a third and a fourth set of through channels, the third layer being disposed between the first and second layers;

the laminated arrangement having first and second inlet ports, and first and second outlet ports;

wherein the first inlet port, the first set of through channels, the third set of through channels, and the first outlet port, define a first fluid flow path;

wherein the second inlet port, the second set of through channels, the fourth set of through channels, and the second outlet port, define a second fluid flow path; and

wherein the bonded layers of the laminated arrangement prevent fluid communication between the first fluid flow path and the second fluid flow path.

[Claim 21] 21. The bipolar plate of the electrochemical cell of Claim 20, wherein:

the third layer is diffusion bonded to the first and second layers.

[Claim 22] 22. The bipolar plate of the electrochemical cell of Claim 21, wherein:

the first, second, and third, layers are made from titanium, zirconium, stainless steel, or any combination comprising at least one of the foregoing materials.